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THE ROLE OF MATERNAL POSTPARTUM DEPRESSION ON NEWBOR AND SIBLINGS' BEHAVIOUR

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The Role of Maternal Postpartum Depression on Newborn and Siblings' Behaviour

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Abstract

In this paper, we study whether maternal postpartum depression affects children's behaviour, not only of the newborn but also of his older siblings. Moreover, we investigate if the presence of older siblings in household softens the impact of maternal distress on the behaviour of the newborn. Using data from the Millennium Cohort Study (UK data service), we estimate the effect of maternal postpartum depression on five behavioural dimensions derived from the Strengths and Difficulties questionnaire, for both newborn and older siblings (when present). Results confirm the association between maternal postpartum depression and behavioural problems. Conversely no significant difference emerged between newborn and older siblings, we found no evidence of a role of older siblings in mitigating the negative consequences of maternal postpartum depression on newborn non-cognitive development. Our findings are robust to different specification of behavioural problems. Overall, our results suggest that newborn and older siblings are similarly exposed to the negative consequences of maternal distress.

Keywords: Maternal postpartum depression; siblings; Strengths and Difficulties questionnaire; early childhood development.
JEL classification: I12, J13.

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1   Introduction

Over the past decades, extensive biological and behaviour developmental research has provided evidence that early environmental conditions in life affect the development of cognitive and non-cognitive skills, which have relevant consequences in human capital formation. From birth to age five, a child's brain develops rapidly in order to build the foundation of cognitive and character skills (Shonkoff, 2010; Shonkoff and Phillips, 2000).

Children are high sensitive to the effects of both positive and negative experiences (Heim and Nemeroff, 2001). Cognitive, linguistic competencies, as well as social and emotional competencies, are all shaped by experiences during childhood (Knudsen et al., 2006). From this development there comes the later child's learning capacity, behaviour, physical and mental health. According to research on human development, learning is a dynamic process, in which early competences acquired in one period become the tools for developing new ones (Heckman, 2000). Indeed, early childhood cognitive and soft skills have been shown to be important determinants of educational attainment, earnings, less risky behaviours, and criminal activity as well (Knudsen et al., 2006; Heckman, 2007; Cunha and Heckman, 2007). Among the risk factors to a child's healthy development, we can include: low income, limited parent education, parental mental health problems, significant social deprivation or neglect, exposure to interpersonal violence, abuse (Rutter et al., 2001; Knudsen et al., 2006). Maternal mental distress is indeed reported as a risk factor for child cognitive and non-cognitive development.

Murray and Cooper (1997) in their review found evidence that postpartum depression is associated with adverse child cognitive and emotional outcomes, in particular in boys development. A considerable body of research suggests that postpartum depression disrupts the normal infant bonding with the mother by affecting maternal interpersonal functioning, and therefore impair infant developmental progress. The 'sensitive period' for mother-child bond formation is indeed identified in the first four months of newborn's life (Moehler et al., 2006). Shaw and Vondra (1995) reported that three-years old boys with insecure attachments in infancy showed more behavioural problems than those who were considered as securely attached in infancy. However, the mechanism of transmission from maternal distress to offspring's outcomes is still not clear and need further investigation.

Using data from the AVON Longitudinal Study of Parent & Children, O'Connor et al. (2003) found that antenatal maternal anxiety predict behavioural/emotional problems for both boys and girls at the age of 4 years. The authors suggested that maternal mood may have an effect on the fetal brain development, with subsequent consequences on the behavioural development of the child. Whereas Hay and Kumar (1995) found that children of mothers who experienced postpartum depression showed poorer cognitive development at the age of four, but higher levels of maternal education seem to act as a protective factor. Sohr-Preston and Scaramella (2006) reported that children, who were exposed to chronically depressed mothers during their infancy, show reduced language skills and cognitive development. Similarly, using data from the National Maternal and Infant Health Survey (U.S. data), Petterson and Albers (2001) found evidence that maternal depression threatens the cognitive and motor development in infancy and early childhood. The reported effect varies across gender and different exposure to maternal depression: boys were more sensitive to severe depression cases than moderate depression ones; girls were sensitive to both moderate and severe depression cases with consequences more on cognitive than on motor development.

As it regards non-cognitive development, Luoma et al. (2001) argued that children of mothers who experienced postpartum depression show on average less social competence. Conversely to

previous studies, Gjerde et al. (2017) found no association between maternal perinatal depression and child behaviour outcomes. They found instead that concurrent maternal depressive symptoms influence internalizing and externalizing problems. Using data from the Norwegian Mother and Child Cohort study (MoBa), they performed multilevel analyses exploiting a sibling comparison. The information about siblings' behaviour was used only to get ride of family confounding as unmeasured genetic and the same family environment. No analysis was carried out to investigate sibling development per se.

Actually, much of the available literature on the effects of maternal postpartum depression deals with questions concerning the well-being either of the mother or the newborn. Chase-Brand (2008) argued that also older children are at significant risk when the mother becomes depressed following the birth of the new sibling. With the arrival of the newborn, older siblings have to learn to deal with changes in the family dynamics. Preschool children may react with regressive behaviors, imitation of infantile behaviors, as well as showing anxiety, depressive symptoms, become withdrawn, quiet or tearful. Some children may also exhibit acting-out behaviours. These behaviours are temporary, if parents provide emotional support to older children and intervene when needed. However, when parent is suffering from postpartum depression, he may not be able to reassure older children and the previous enumerated symptoms may last longer.

At the same time, when a parent suffers from postpartum depression, teenagers may receive more responsibilities within the household. They may be asked to take care of younger children with negative consequences on their academic performance and social achievement. As pointed out by Chase-Brand (2008), most of the existing studies consider the effect of all forms of maternal depression on offspring at different ages, but not of just postpartum depression following the birth of a new child. Unfortunately, Chase-Brand (2008) did not show empirical evidence of her claims.

The aim of this paper is to clarify the effects of maternal postpartum depression on behavioural development of both newborn and older siblings. If the mother is suffering from psychological distress, we assume that older siblings are asked to be more involved in household chores and to look after the newborn, and therefore we expect to see a mitigation effect on the negative consequences of maternal postpartum depression. This increased responsibility request from older siblings may enhance their non-cognitive skills and consequently be empowered. The rest of the paper proceeds as follows: in Section 2 data are described and the main variables are defined, in Section 3 the empirical strategy is outlined, in Section 4 results are illustrated, in Section 5 robustness checks are discussed, eventually in Section 6 conclusions are drawn.

2 Data description and variables definition

2.1 Data description

The Millennium Cohort Study (MCS) is a multidisciplinary longitudinal survey conducted by the Centre for Longitudinal Studies, following the life of around 19,000 children born in the United Kingdom between September 2000 and January 2002. The sample design allowed for an oversampling of families living in disadvantaged areas, in the smaller nations of the UK, and in areas with high ethnic minority populations in England. These are the groups of families who are usually hard to reach (Connelly and Platt, 2014). Data were collected when children were around 9 months of age, and in a series of follow-up surveys at different ages (3, 5, 7, 11, etc.). At each sweep, home visits interviews were conducted and parents were asked to answer to some questions via self-completion as well. Questions did not regard only cohort member (CM), but some questions were

about all household components. It was gathered a wide range of information regarding socioeconomic circumstances, demographic characteristics, parenting activities, attitudes, parental physical and mental health.

Starting from the second sweep, when cohort member was 3 years old, parents were asked to complete the Strength and Difficulties Questionnaire on the basis of cohort member's behaviour over the previous six months. In addition to this, in the second and third sweep, the Strength and Difficulties Questionnaire was repeated for each cohort member's older sibling aged 15 or less, up to a maximum of two older siblings selected by chance by the computer. The Strength and Difficulties Questionnaire is a behavioural screening questionnaire conceived by the psychiatrist Goodman (1997) for detecting behavioural problems in children and adolescent.

To the aim of the present study, we consider data collected in the first three waves. We use the information contained in the first wave to identify maternal postpartum depression and to define other controls variables; while we use data of the second and the third wave in order to detect behavioural problems in cohort members and older siblings. We select the families which were interviewed in the first wave and in at least either the second or the third wave. We restrict the sample to single-birth children, since twins experience different development path (Mittler, 1971; George et al., 2007), and the care of twins may also be more demanding and affect the wellness of the mother. Based on the availability of the information about our dependent variables, we run the analyses on three sub-samples: the first composed by families interviewed in the first and in the second wave (unit of observation: cohort member); the second composed by those who participate in the first and in the third wave (unit of observation: cohort member); the third composed by families with the presence of older children than the cohort member (natural sibling or half-brother/sister with the same mum) who participate in the first wave and at least in one of the following two waves (unit of observation: older sibling). In Appendix, Tables 1 and 4 show the descriptive statistics respectively for the cohort members' sub-samples (around 13,100 observations each), and for the older siblings' sample (around 18,200 observations in total).

2.2 Variables definition

Strength and Difficulties Questionnaire

The Strength and Difficulties Questionnaire (SDQ) is a validated behavioural screening questionnaire for children and adolescent between aged 4/17 (Goodman, 1997). An aged appropriate version is available also for children 2/4 years old. The SDQ was mostly completed by the mother of the cohort member who may have suffered from postpartum depression nonetheless. However, there is no evidence that depressed mothers report negative biased information in offspring's behaviour (Richters, 1992). The SDQ is composed by 25 items on psychological attributes, divided in five dimensions, namely: emotional symptoms, conduct problems, hyperactivity/inattention, peer problems and prosocial behaviour. Each behavioural/emotional dimension is measured with 5-items of the questionnaire. In detail, emotional symptoms dimension refers to the following attributes: fears, worries, misery, nerves, somatic symptoms. Conduct problems dimension includes the information about: fit of temper, obedience, fighting, lying (argumentative with adults in the age 3 version), and stealing (spiteful in the age 3 version). Hyperactivity/inattention includes instead: restlessness, constantly fidgeting, distractability, concentration, and impulsivity. Peer relationship problems dimension covers: popularity, victimization, isolation, friendship, and ability to relate to children as compare to adults. Eventually, the prosocial behaviour dimension refers to: consideration of others'

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feelings, ability to share with other children, kindness to younger children, helpfulness when other children are hurt, and willingness to volunteer to help others.

To each questionnaire item, the parent could choose if it was 'not true', 'somewhat true' or 'certainly true'. The responses are rated using a scale from 0 to 2, where 0 is given to the answer 'not true', 1 to 'somewhat true', and 2 to 'certainly true' (in specific cases the scale is reverse[1]). By behavioural dimension, the item-scores are then summed up[2] in order to provide a total score ranging from 0 to 10. A high score in emotional symptoms, conduct problems, hyperactivity/inattention, and peer relationship problems dimension identifies behavioural problems. On the other side, an high score in prosocial behaviour is desirable, whereas a low score identifies behavioural problems to which we can refer as anti-social behaviours.

Clinically relevant cut-points, for measuring behavioural problems are determined as the score of the last decile (first decile in case of prosocial behaviour score) of all children with available SDQ data in that sub-sample (McMunn et al., 2012; Goodman, 2001). Depending on the sub-sample we are considering, cohort members at age 3, cohort members at age 5 or older siblings' sub-sample, we have a different cut-point for each SDQ behaviour dimension. As far as the older siblings' sub-sample is concerned, since children are not the same age, we have checked whether the distribution of the SDQ score per dimension differs from age group to age group but no considerable difference appears (see Figures 6 - 10 in Appendix). Therefore, we decide to take advantage of a bigger sample size and keep the whole distribution of older siblings when determining the cut-points.

Then, for each SDQ behaviour dimension we generate a dummy equal to one if the reported score is equal or higher than the corresponding cut-point, conversely the variable measuring anti-social behaviour is equal to one if the score is lower or equal to the cut-point.

Maternal Postpartum depression

We identify maternal postpartum depression using a modified version of the Malaise Inventory, where only 9 items were selected (as documented in the technical report of the first MCS sweep). The mother answered via self-completion to 9 'yes-no' questions regarding her mental well-being[3]. The set of questions are used to detect physical and psychological symptoms of anxiety and depression. A score of 4 or above, out of 9, is considered a signal of psychological distress. Therefore, as done in Flouri et al. (2010) and Malmberg and Flouri (2011), we construct our indicator of maternal postpartum depression as a dummy variable which takes value equal to one in the case in which the Malaise Inventory score is equal or higher than four.

3   Empirical strategy

In order to understand the role of maternal postpartum depression on the behaviour of newborn and his older siblings, two analyses are carried out separately. In the first analysis, we assess the impact of maternal postpartum depression on newborn's as he grows up and whether the presence of siblings living in household mitigate this possible negative effect. Therefore, we perform a probit regression models for each SDQ behavioural dimension at age 3 and at age 5, to see if the effect

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[1]See Goodman (1997).

[2]The sum was derived using the method defined at http://www.sdqinfo.org/c1.html for the parental test.

[3]Whether she felt tired, miserable or depressed, worried, often get into a violent rage, become scared, easily upset or irritated, keyed up and jittery, every little thing get on her nerves and wear them out, and heart often race like mad.

decreases as the child grows up. We can define the estimated model with the following equation:

$$Y_{i,t} = \alpha_t + \beta_t PPD_{i,t=0} + \gamma_t PPD_{i,t=0} * Sib_{i,t=0} + \theta t Z'_{i,t=0} + \eta_t K'_{i,t} + \varepsilon_{i,t} \qquad (1)$$

where $Y_{i,t}$ represents a behavioural dimension problem of child i at time t; $PPD_{i,t=0}$ stands for maternal postpartum depression measured when the child was 9 months old; $PPD_{i,t=0} * Sib_{i,t=0}$ is the interaction between maternal postpartum depression and the presence of at least one sibling at the time of cohort member's birth; $Z'_{i,t=0}$ is a set of child, mother, family and environmental characteristics measured at the time of the first interview, when the child was 9 months old; $K'_{i,t}$ refers to those control variables, as age and country interview, that change between waves; and $\varepsilon_{i,t}$ is the error term.

As it regards the analysis on older siblings, we perform a panel random effects probit model for each SDQ behavioural dimension, assuming that the random effect is uncorrelated with explanatory variables. The model can be expressed as follows:

$$Y_{i,t} = \beta PPD_{i,t=0} + \gamma PPD_{i,t=0} * w_t + \lambda w_t + \theta X'_{i,t=0} + V'_{i,t} + u_{i,t} \qquad (2)$$

where $Y_{i,t}$ represents a behavioural dimension problem (one of the five SDQ dimension) of older sibling i at time t; $PPD_{i,t=0}$ stands for maternal postpartum depression measured when the cohort member was 9 months old; $PPD_{i,t=0} * w_t$ refers to the interaction between maternal postpartum depression and time distance from cohort member's birth (in order to see if the effect decreases over time or it persists); w_t is a dummy variable indicating if the observation belongs to wave 3, rather than wave 2; $X'_{i,t=0}$ is a set of older sibling, mother, family and environmental characteristics measured at the time of the first interview when the cohort member was 9 months old; $V'_{i,t}$ refers to those control variables as age and country interview that change between waves; and $u_{i,t}$ is the composite error term equal to the sum of the unobserved individual effect α_i and the idiosyncratic error $\varepsilon_{i,t}$.

All models adjust for child, mother, family and environment's characteristics. Firstly, as child characteristics, we consider gender, age and age squared. Secondly, as mother's characteristics we include: ethnic group (the six categories Census class[4]), age at CM's birth, highest academic or vocational education attained (National Vocational Qualification[5] equivalent), healthy behaviours during the pregnancy of CM (smoking, consumption of alcohol), and longstanding illness (it refers to anything that has troubled the person over a period of time, or that is likely to affect her over a period of time), disability or infirmity. Thirdly, we select the following family's characteristics: presence of the natural father in household, combined labour market status of the mother and the partner[6], predicted equivalised weekly net family income in logarithmic form, and if maternal grandparents were alive.

It is important to include family characteristic's in the model, since they may affect both the outbreak of maternal postpartum depression and child's outcomes. Targosz et al. (2003) found that psychological disorders appear to be more frequent in lone mothers, however after controlling for

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[4]White, Mixed, Indian, Pakistani and Bangladeshi, Black or Black British, and other Ethnic group.

[5]National Vocational Qualifications were competence-based qualifications built on national occupational standards and criteria established by OfQual - Office of Qualifications and Examinations Regulation in England.

[6]The considered status are: mother and partner in work; mother in work but partner not; partner in work but mother not; mother and partner not in work; mother in work or on leave and no partner; mother not in work nor on leave and no partner; mother in work and partner status unknown; mother not in work and partner status unknown.

measures of social disadvantage, stress and isolation, the increased rates of depressive condition in lone mothers were no more evident.

As far as employment patterns are concerned, previous studies have shown either no evidence, or positive effect of maternal employment on subequent child's socio-emotional behaviours (Vandell and Ramanan, 1992; Cooksey et al., 2009). McMunn et al. (2012) found that parental working arrangement of both parents have different effect on boys and girls. The most striking result that emerges from their study is that maternal employment, when two parents are present, has a positive effect on socio-emotional behaviour of girls.

Eventually, as environment's characteristics we look at the interview country (namely England, Walles, Scotland, and Northern Ireland), as well as at parents' claim of pollution, grime or environmental problems in the neighbour area at time of the first interview. All control variables, except for country of interview and age of the child, are measured at the time of the first interview, when cohort member was 9 months old.

Moreover, as it regards the analysis on cohort members' data we specify a dummy equals to one in case there were older siblings living in the household at cohort member birth. Conversely, as it regards the analysis on older siblings' data we include: a dummy which takes value equal to one in case that the sibling is a half-brother/sister, a dummy if he is the first-born, and a time dummy indicating the wave when the behavioural problems were detected.

4   Results

In line with the literature, we found that maternal postpartum depression increases the probability of revealing problems in all SDQ behavioural dimensions. Tables 1 and 2 present the marginal effect of maternal postpartum depression, its interaction with siblings, and other relevant control variables on child behavioural. At age 3, cohort members with a mother who suffered from postpartum depression are 7.4% more likely to show emotional symptoms, 6.5% more likely to present conduct problems, 5.6% more likely to reveal hyperactivity or inattention, and 4.6% more likely to show peer relationship problems with respect to other cohort members. The reported effects are all statistically significant at 1% level, while the marginal effect of postpartum depression on anti-social behaviours, equal to 3.6%, is statistically significant at 5% level.

At age 5, the effect of maternal postpartum depression is statistically significant at 1% level for all SDQ behavioural dimensions. Children with a mother, who experienced postpartum depression after their birth, are more likely to be reported with behavioural problems. Further statistical tests revealed that postpartum depression's marginal effects are not statistically different between age 3 and age 5, with the exception of marginal effects on peer relationship problems. The marginal effect of postpartum depression on peer problems passes from 4.6% at age 3 to 8.4% at age 5, and the difference is statistically significant at 5% level. This rise in magnitude may be due to the fact that, at age 3 a child has fewer opportunities to interact with other children of the same age, and consequently, fewer peer problems may be revealed.

From the estimated marginal effects, we can see that the interaction between siblings and postpartum depressions is never significant with the exception of its marginal effect on the regression of peer relationship problems at the age of 3. In the last case, the interaction between postpartum depression and siblings is significant at 10% level. Interestingly, the effect is positive, children with older siblings and a mother who suffered from postpartum depression are 2.4% more likely to be reported with peer relationship problems with the respect to others. Overall the presence of siblings does not mitigate the impact of maternal postpartum depression on newborn. On the other hand,

the presence of siblings living in household at child's birth, is found to be significant in all the regressions of SDQ behavioural/emotional problems, with the exception of hyperactivity/inattention. However, the direct effect of siblings is not always in the same direction, it seems to make more likely for cohort members to present conduct problems and anti-social behaviours, conversely it makes them less likely to show emotional symptoms, and peer relationship problems.

Findings about cohort members can be compared with the ones on older siblings (presented in Table 3). Being exposed to maternal postpartum depression makes older siblings more likely to show behavioural problems with respect to other children. However, statistical tests revealed that overall maternal postpartum depression did not affect newborns and older siblings differently. The marginal effects of maternal postpartum depression have almost the same size whether it refers to the analysis on cohort member's behaviour, or on the older siblings' one. Interestingly, the impact of maternal distress does not diminish whether it has passed five years rather than three years from the outbreak of it (the interaction between postpartum depression and the time dummy is not significant).

5 Robustness checks

A final series of analyses was carried out to demonstrate that our findings hold across different definitions of behavioural problems and to check that they are not driven by extreme score of behavioural/emotional problems. Therefore, we decided to consider different cut-point in the determination of the behavioural problems, namely the score of the last 20th and 30th percentile (the first 20th and 30th percentile for the definition of anti-social behaviours). In some cases the score associated to the 20th and of the 30th coincides and, consequently, we get the same estimated results.

As can been seen from Tables 4-6, the link between postpartum depression and children's behavioural/emotional problems is strong and significant for all SDQ dimensions, in the analysis both on cohort members and on older siblings. The interaction between maternal postpartum depression and older siblings is never significant in the regression of cohort members' behavioural problems, as well as the interaction between postpartum depression and time-dummy. Therefore, we can consider our findings robust to different definitions of behavioural/emotional problems.

Table 1: Marginal effect of maternal postpartum depression on CM's behavior at the age of 3

	(1) Emotional symptoms	(2) Conduct problems	(3) Hyperactivity / inattention	(4) Peer problems	(5) Anti-social behavior
Postpartum depression	0.0740***	0.0654***	0.0564***	0.0458***	0.0356**
	(0.0142)	(0.00989)	(0.0125)	(0.0114)	(0.0154)
Interaction postpartum depression and older siblings	0.0263	-0.000677	0.0149	0.0239*	-0.00852
	(0.0178)	(0.0123)	(0.0158)	(0.0145)	(0.0190)
Older siblings living in HH (S1)	-0.0149*	0.0257***	-0.00386	-0.0346***	0.0483***
	(0.00811)	(0.00617)	(0.00726)	(0.00674)	(0.00796)
Male	0.00145	0.0126***	0.0642***	0.0207***	0.0686***
	(0.00665)	(0.00489)	(0.00595)	(0.00555)	(0.00662)
Age of CM (days)	0.000413	-0.00105*	-0.000684	-0.00188***	-0.00195**
	(0.000831)	(0.000618)	(0.000744)	(0.000680)	(0.000871)
Age of CM (days) squared/1000	-0.000139	0.000386	0.000258	0.000719***	0.000689**
	(0.000331)	(0.000247)	(0.000296)	(0.000270)	(0.000349)
Natural father resident in HH (S1)	0.157**	-0.0306	-0.0272	-0.0530	0.0250
	(0.0748)	(0.0347)	(0.0513)	(0.0425)	(0.0623)
Observations	13201	13224	13105	13111	13131

Notes: S1 stands for data taken from the first wave of MCS, when the cohort member was 9 months old. HH stands for household. CM stands for cohort member. The model includes controls for: age of the mother at CM's birth, mother's longstanding illness, disability or infirmity (S1), mother's ethnic group, mother's highest academic qualification - NVQ (S1), mother's healthy behaviours during the pregnancy of CM (smoking, drinking alcohol), combined labour market status of the mother and of the partner, predicted equivalised weekly net family income in logarithmic form (S1), if maternal grandmother and grandparent are alive (S1), pollution, environmental problems (S1), interview country (E, W, S, NI). Standard errors in parentheses. $* \ p < 0.10$, $** \ p < 0.05$, $*** \ p < 0.01$

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Table 2: Marginal effect of maternal postpartum depression on CM's behavior at the age of 5

	(1) Emotional symptoms	(2) Conduct problems	(3) Hyperactivity / inattention	(4) Peer problems	(5) Anti-social behavior
Postpartum depression	0.0668***	0.0568***	0.0450***	0.0836***	0.0383***
	(0.00991)	(0.00996)	(0.0102)	(0.0129)	(0.0137)
Interaction postpartum depression and older siblings	0.00886	0.00123	0.00288	-0.00280	0.00231
	(0.0126)	(0.0123)	(0.0128)	(0.0164)	(0.0170)
Older siblings living in HH (S1)	-0.0216***	0.0246***	0.00313	-0.0285***	0.0250***
	(0.00617)	(0.00604)	(0.00607)	(0.00751)	(0.00731)
Male	-0.00853*	0.0316***	0.0565***	0.0259***	0.0800***
	(0.00501)	(0.00479)	(0.00495)	(0.00622)	(0.00607)
Age of CM (days)	0.00106	-0.000915	0.000467	0.000220	0.000759
	(0.000878)	(0.000817)	(0.000859)	(0.00108)	(0.00108)
Age of CM (days) squared/1000	-0.000278	0.000231	-0.000130	-0.0000739	-0.000245
	(0.000230)	(0.000214)	(0.000225)	(0.000284)	(0.000283)
Natural father resident in HH (S1)	-0.0447	-0.0167	-0.00225	-0.0333	-0.0562
	(0.0383)	(0.0365)	(0.0401)	(0.0519)	(0.0498)
Observations	13207	13223	13160	13193	13220

Notes: S1 stands for data taken from the first wave of MCS, when the cohort member was 9 months old. HH stands for household. CM stands for cohort member. The model includes controls for: age of the mother at CM's birth, mother's longstanding illness, disability or infirmity (S1), mother's ethnic group, mother's highest academic qualification - NVQ (S1), mother's healthy behaviours during the pregnancy of CM (smoking, drinking alcohol), combined labour market status of the mother and of the partner, predicted equivalised weekly net family income in logarithmic form (S1), if maternal grandmother and grandparent are alive (S1), pollution, environmental problems (S1), interview country (E, W, S, NI). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Marginal effect of maternal postpartum depression on older siblings' behavior.

	(1) Emotional symptoms	(2) Conduct problems	(3) Hyperactivity / inattention	(4) Peer problems	(5) Anti-social behavior
Postpartum depression (PPD)	0.0791***	0.0630***	0.0411***	0.0392***	0.0470***
	(0.00706)	(0.00788)	(0.00724)	(0.00756)	(0.00978)
Male	-0.00692	0.0449***	0.0869***	0.0346***	0.0812***
	(0.00470)	(0.00524)	(0.00495)	(0.00485)	(0.00608)
Age (years)	0.0174***	-0.00452	0.0165***	0.0121***	-0.0369***
	(0.00466)	(0.00486)	(0.00450)	(0.00464)	(0.00560)
Age (years)/100	-0.0994***	0.0300	-0.107***	-0.0521**	0.219***
	(0.0246)	(0.0254)	(0.0239)	(0.0242)	(0.0290)
Half-brother/Half-sister	0.00913	0.0437***	0.0194**	0.0305***	0.0158
	(0.00897)	(0.0108)	(0.00951)	(0.00990)	(0.0115)
First born vs others	0.0136**	-0.0267***	-0.0287***	-0.00585	-0.0326***
	(0.00532)	(0.00574)	(0.00533)	(0.00535)	(0.00665)
Natural father of older sibling and CM interviewed (S1)	0.00180	-0.00653	-0.0167**	0.00349	-0.0148
	(0.00770)	(0.00853)	(0.00788)	(0.00790)	(0.00984)
Interaction PPD and time distance from CM's birth	-0.00861	-0.00779	0.00674	0.00296	-0.0129
	(0.00866)	(0.00960)	(0.00829)	(0.00899)	(0.0117)
Rho	0.56872	0.61301	0.71995	0.61578	0.59581
	(0.02247)	(0.01999)	(0.01680)	(0.02081)	(0.01813)
Observations	18199	18244	18192	18213	18231

Notes: S1 stands for data taken from the first wave of MCS, when the cohort member was 9 months old. HH stands for household. CM stands for cohort member. The model includes controls for: age of the mother at CM's birth, mother's longstanding illness, disability or infirmity (S1), mother's ethnic group, mother's highest academic qualification - NVQ (S1), mother's healthy behaviours during the pregnancy (smoking, drinking alcohol), combined labour market status of the mother and of the partner, predicted equivalised weekly net family income in logarithmic form (S1), if maternal grandmother and grandparent are alive (S1), pollution, environmental problems (S1), interview country (E, W, S, NI). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Impact of maternal postpartum depression on CM's behavior at the age of 3

	(1) Emotional symptoms	(2) Conduct problems	(3) Hyperactivity / inattention	(4) Peer problems	(5) Anti-social behavior
Cut-point for behavioural problems: the last 20th percentile of the SDQ score					
Postpartum depression	0.0991***	0.163***	0.0992***	0.0746***	0.0409**
	(0.0192)	(0.0189)	(0.0161)	(0.0166)	(0.0192)
Interaction postpartum depression and older siblings	0.0367	-0.0215	0.0150	0.0280	0.0171
	(0.0241)	(0.0237)	(0.0203)	(0.0210)	(0.0239)
Older siblings living in HH (S1)	-0.0145	0.0496***	-0.0214**	-0.0382***	0.0582***
	(0.0100)	(0.0100)	(0.00893)	(0.00911)	(0.00979)
Cut-point for behavioural problems: the last 30th percentile of the SDQ score					
Postpartum depression	0.0991***	0.163***	0.136***	0.0916***	0.0409**
	(0.0192)	(0.0189)	(0.0201)	(0.0205)	(0.0192)
Interaction postpartum depression and older siblings	0.0367	-0.0215	-0.00393	0.0322	0.0171
	(0.0241)	(0.0237)	(0.0252)	(0.0258)	(0.0239)
Older siblings living in HH (S1)	-0.0145	0.0496***	-0.0332***	-0.0464***	0.0582***
	(0.0100)	(0.0100)	(0.0103)	(0.0104)	(0.00979)
Observations	13201	13224	13105	13111	13131

Notes: S1 stands for data taken from the first wave of MCS, when the cohort member was 9 months old. HH stands for household. CM stands for cohort member. The model includes controls for: gender, age and age squared, age of the mother at CM's birth, mother's longstanding illness, disability or infirmity (S1), mother's ethnic group, mother's highest academic qualification - NVQ (S1), mother's healthy behaviours during the pregnancy of CM (smoking, drinking alcohol), combined labour market status of the mother and of the partner, presence of the natural father at time of CM's birth, predicted equivalised weekly net family income in logarithmic form (S1), if maternal grandmother and grandparent are alive (S1), pollution, environmental problems (S1), interview country (E,W,S,NI). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Impact of maternal postpartum depression on CM's behavior at the age of 5

	(1) Emotional symptoms	(2) Conduct problems	(3) Hyperactivity / inattention	(4) Peer problems	(5) Anti-social behavior
Cut-point for behavioural problems: the last 20th percentile of the SDQ score					
Postpartum depression	0.132***	0.0981***	0.134***	0.104***	0.0576***
	(0.0192)	(0.0159)	(0.0176)	(0.0181)	(0.0175)
Interaction postpartum depression and older siblings	0.0166	-0.000360	-0.0354	-0.0147	0.0119
	(0.0242)	(0.0198)	(0.0222)	(0.0229)	(0.0217)
Older siblings living in HH (S1)	-0.0395***	0.0507***	-0.0163*	-0.0581***	0.0322***
	(0.0100)	(0.00877)	(0.00950)	(0.00962)	(0.00909)
Cut-point for behavioural problems: the last 30th percentile of the SDQ score					
Postpartum depression	0.132***	0.135***	0.146***	0.104***	0.0752***
	(0.0192)	(0.0205)	(0.0206)	(0.0181)	(0.0203)
Interaction postpartum depression and older siblings	0.0166	-0.00775	-0.0284	-0.0147	-0.0194
	(0.0242)	(0.0259)	(0.0259)	(0.0229)	(0.0255)
Older siblings living in HH (S1)	-0.0395***	0.0666***	-0.0308***	-0.0581***	0.0391***
	(0.0100)	(0.0104)	(0.0104)	(0.00962)	(0.0103)
Observations	13207	13223	13160	13193	13220

Notes: S1 stands for data taken from the first wave of MCS, when the cohort member was 9 months old. HH stands for co-hort member. The model includes controls for: gender, age and age squared, age of the mother at CM's birth, mother's longstanding illness, disability or infirmity (S1), mother's ethnic group, mother's highest academic qualification - NVQ (S1), mother's healthy behaviours during the pregnancy of CM (smoking, drinking alcohol), combined labour market status of the mother and of the partner, presence of the natural father at time of CM's birth, pre-dicted equivalised weekly net family income in logarithmic form (S1), if maternal grandmother and grandparent are alive (S1), pollution, environmental problems (S1), interview country (E,W,S,NI). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

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Table 6: Marginal effect of maternal postpartum depression on older siblings' behavior.

	(1) Emotional symptoms	(2) Conduct problems	(3) Hyperactivity / inattention	(4) Peer problems	(5) Anti-social behavior
Cut-point for behavioural problems: the last 20th percentile of the SDQ score					
Postpartum depression (PPD)	0.152*** (0.0121)	0.0957*** (0.0113)	0.0871*** (0.0115)	0.0700*** (0.0104)	0.0586*** (0.0120)
Half-brother/Half-sister	0.0264* (0.0145)	0.0557*** (0.0140)	0.0565*** (0.0146)	0.0466*** (0.0130)	0.0144 (0.0139)
Interaction PPD and time distance from CM's birth	-0.00728 (0.0144)	-0.0120 (0.0137)	-0.00466 (0.0129)	-0.000895 (0.0124)	-0.00140 (0.0143)
Rho	0.56851 (0.01551)	0.55590 (0.01680)	0.68973 (0.01358)	0.57921 (0.01744)	0.57818 (0.01580)
Cut-point for behavioural problems: the last 30th percentile of the SDQ score					
Postpartum depression (PPD)	0.183*** (0.0144)	0.108*** (0.0143)	0.108*** (0.0134)	0.101*** (0.0136)	0.0690*** (0.0140)
Half-brother/Half-sister	0.0418*** (0.0161)	0.0589*** (0.0164)	0.0454*** (0.0162)	0.0583*** (0.0157)	0.0116 (0.0157)
Interaction PPD and time distance from CM's birth	-0.0175 (0.0172)	0.00119 (0.0167)	0.00308 (0.0148)	-0.00798 (0.0164)	-0.00262 (0.0167)
Rho	0.54486 (0.01450)	0.60078 (0.01380)	0.69871 (0.01229)	0.53709 (0.01541)	0.55045 (0.01469)
Observations	18199	18244	18192	18213	18231

Notes: S1 stands for data taken from the first wave of MCS, when the cohort member was 9 months old. HH stands for household. CM stands for cohort member. The model includes controls for: gender, age and age squared, if he is first-born, age of the mother at CM's birth, mother's longstanding illness, disability or infirmity (S1), mother's ethnic group, mother's highest academic qualification - NVQ (S1), mother's healthy behaviours during the pregnancy (smoking, drinking alcohol), combined labour market status of the mother and of the partner, predicted equivalised weekly net family income in logarithmic form (S1), if maternal grandmother and grandparent are alive (S1), pollution, environmental problems (S1), interview country (E, W, S, NI). Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6   Conclusions

To the best of our knowledge, this is the first study to have assessed if it exists a different impact of maternal postpartum depression on newborn than older siblings' behaviour problems, as well as the role of siblings in mitigating the effect of postpartum depression. Our findings confirm the association between maternal postpartum depression and adverse behavioural/emotional outcomes. We found no significant difference between the effect of maternal postpartum depression on newborn than older siblings. Moreover, we assessed whether the presence of siblings weakens the impact of maternal distress on newborn's behavioural problems. Contrary to expectations, this study did not find a significant effect of the presence of older siblings reducing the negative consequences of maternal postpartum depression.

The evidence from this study suggest that maternal postpartum depression affect offspring's behaviour regardless if he is the newborn or an older sibling. Therefore, it seems that the mechanism through which postpartum depression influences children behaviours go beyond the bond formation between infant and mother, otherwise it would not have an impact on older siblings' behaviours. Moreover, the size of the detrimental effects are very close. The current research was not specifically designed to evaluate the process of transmission between maternal postpartum depression and offspring's behaviour, further work is required to clarify this.

The most important limitation of this study that we must acknowledge, lies in the fact the we have limited information about the pregnancy and the first year of life of older siblings. It may be the case that they were also exposed to adverse events which affect their development in early childhood. Although we can not rule out this possibility, it seems reasonable to us to assume that if the mother decided to carry the new baby to term, she may have successfully overcome a previous postpartum depression. Notwithstanding its limitations, this study suggests that when treating postpartum depression, health care practitioners should take care of the wellness of the mother, the infant, and of older siblings as well.

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Appendix

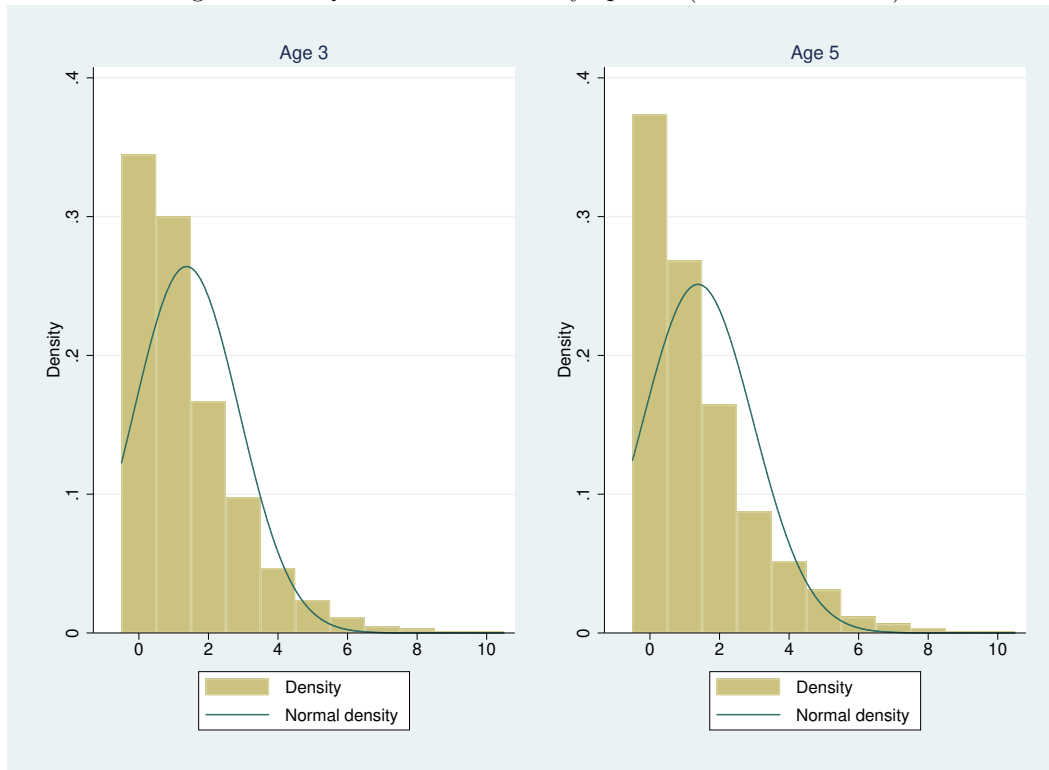Figure 1: SDQ score - Emotional symptoms (Cohort Members)

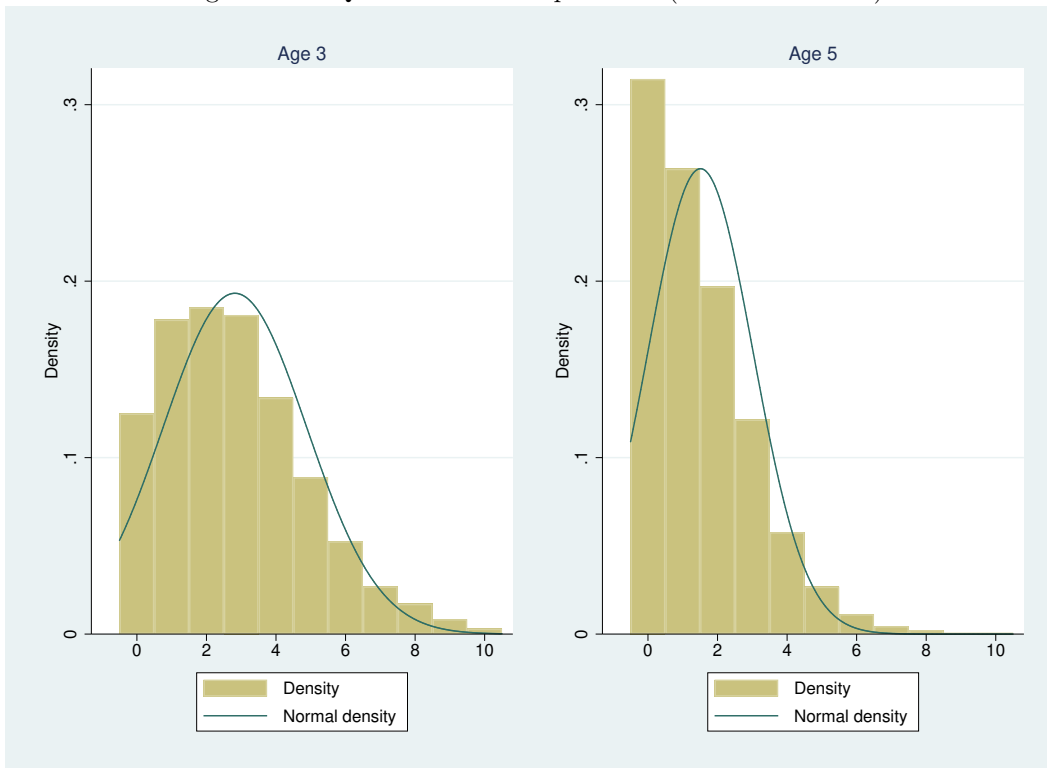Figure 2: SDQ score - Conduct problems (Cohort Members)

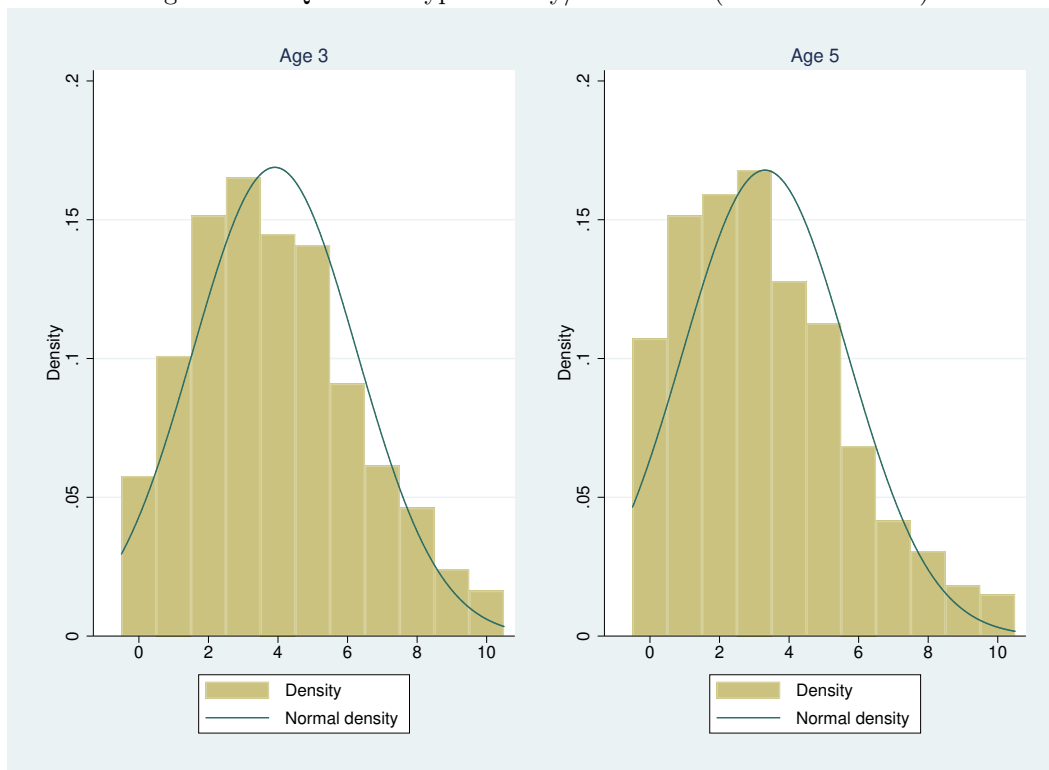Figure 3: SDQ score - Hyperactivity/inattention (Cohort Members)

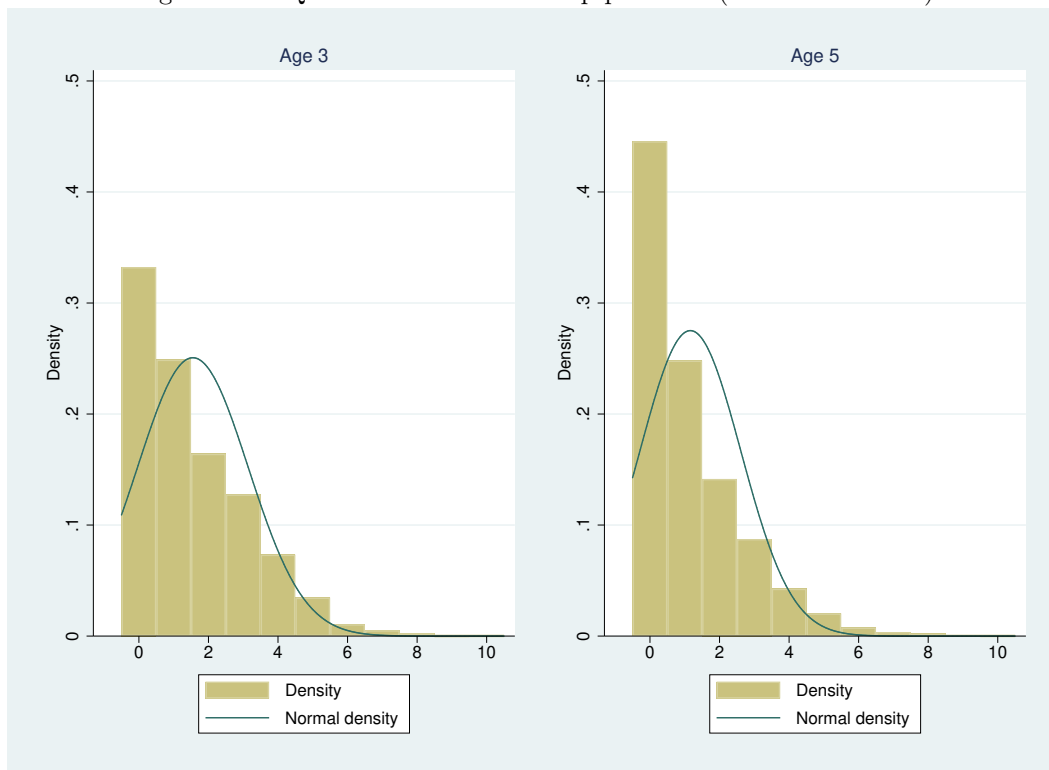Figure 4: SDQ score - Peer relationship problems (Cohort Members)

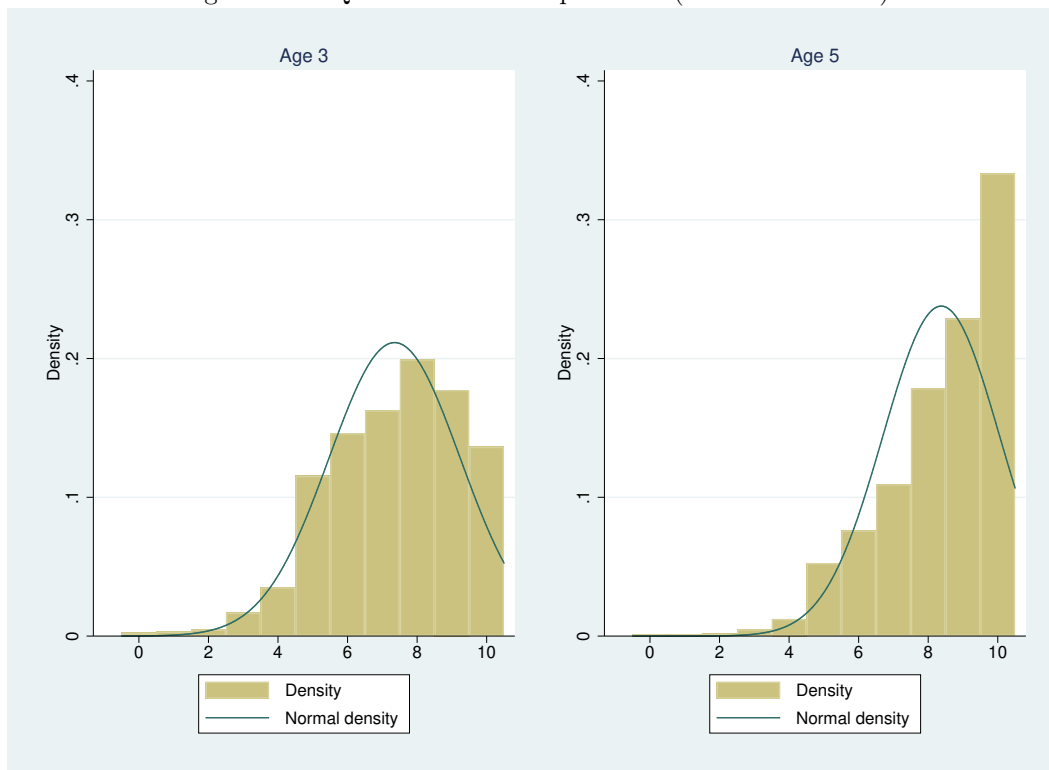Figure 5: SDQ score - Prosocial problems (Cohort Members)

Figure 6: SDQ score - Emotional symptoms (Older siblings)
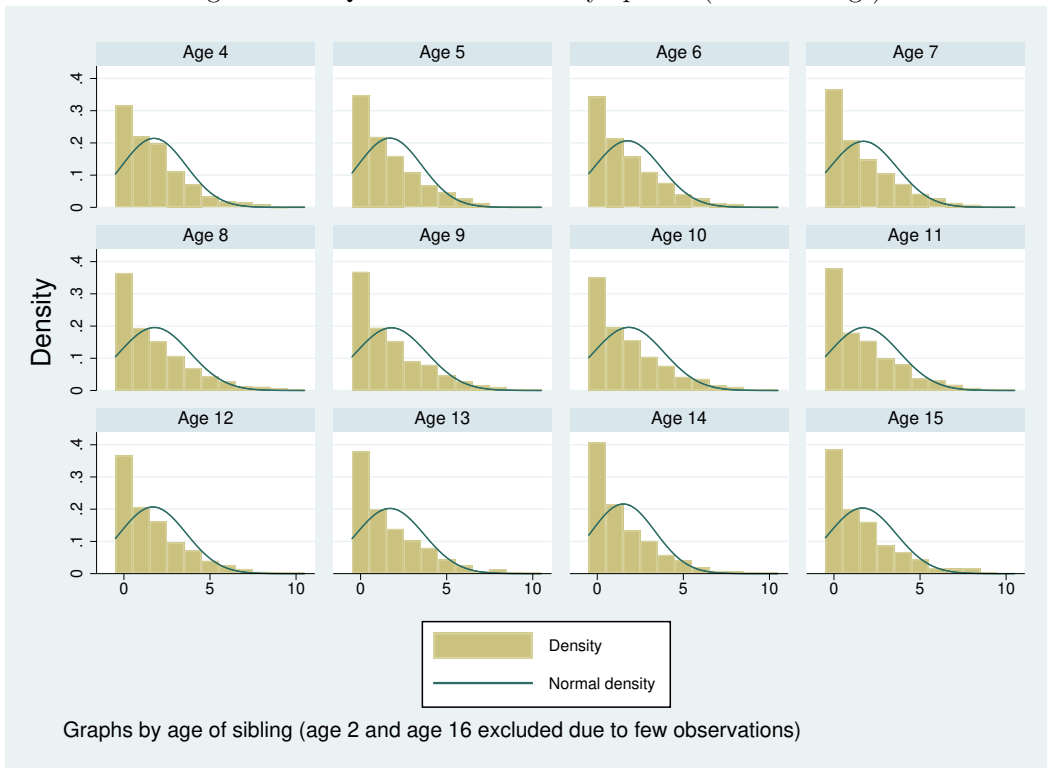
Figure 7: SDQ score - Conduct problems (Older siblings)

Graphs by age of sibling (age 2 and age 16 excluded due to few observations)
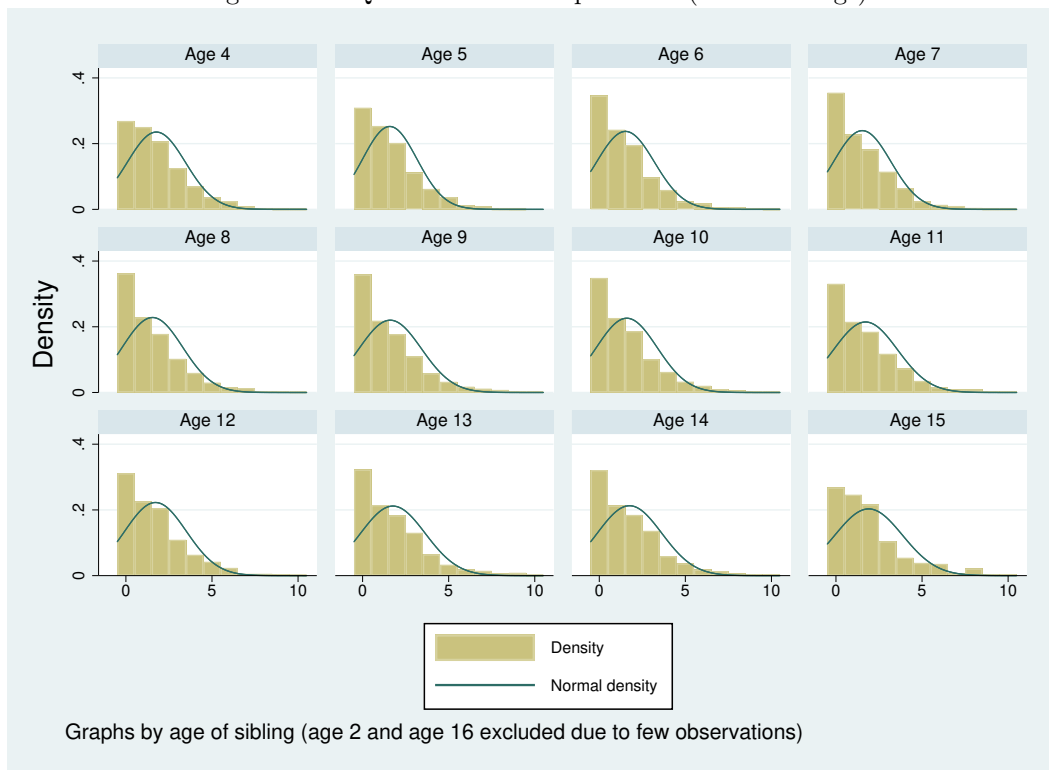
24

Figure 8: SDQ score - Hyperactivity/inattention (Older siblings)
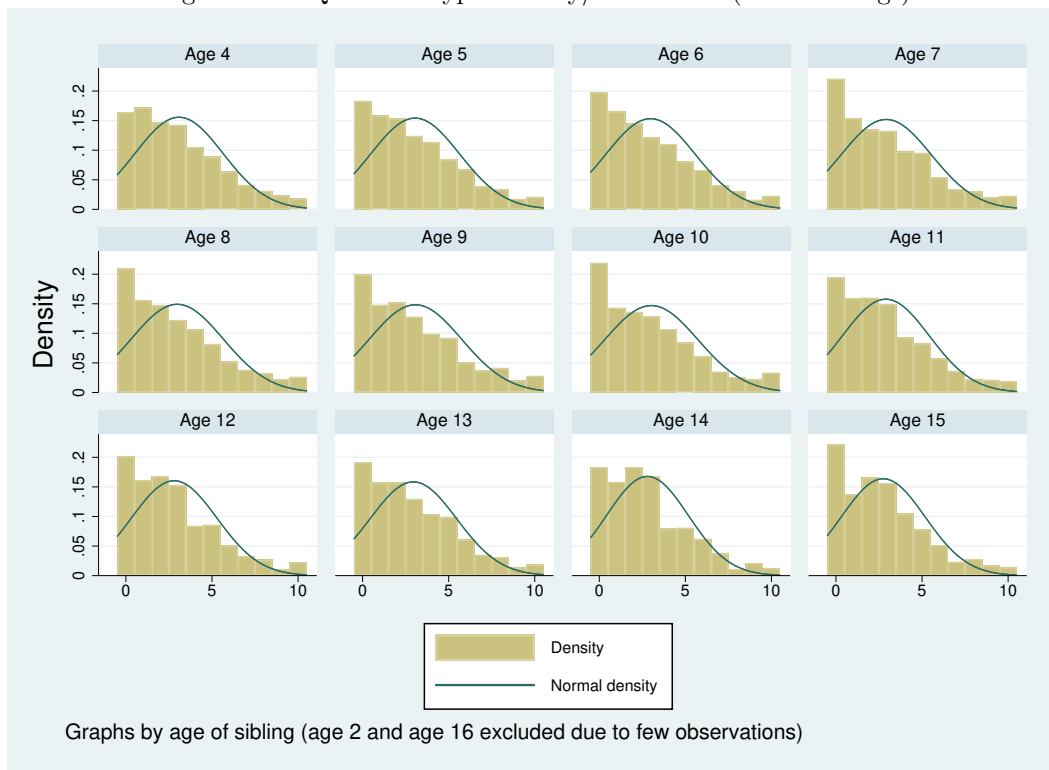
Figure 9: SDQ score - Peer relationship problems (Older siblings)

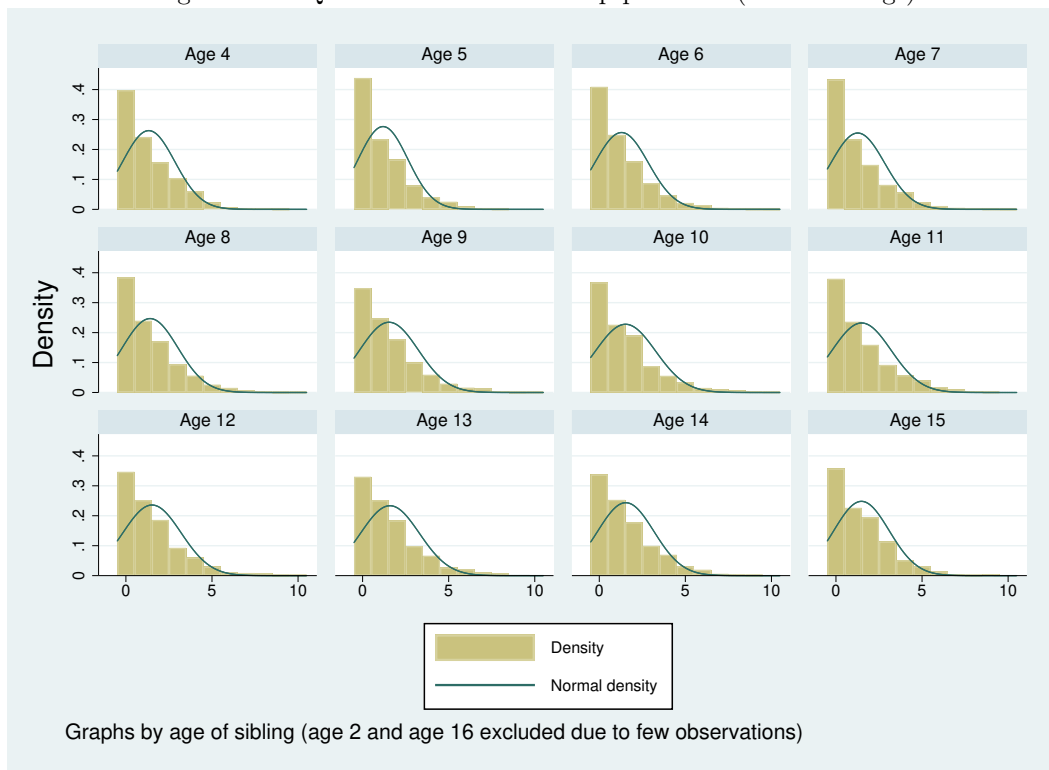Graphs by age of sibling (age 2 and age 16 excluded due to few observations)

Figure 10: SDQ score - Prosocial problems (Older siblings)

Graphs by age of sibling (age 2 and age 16 excluded due to few observations)

27
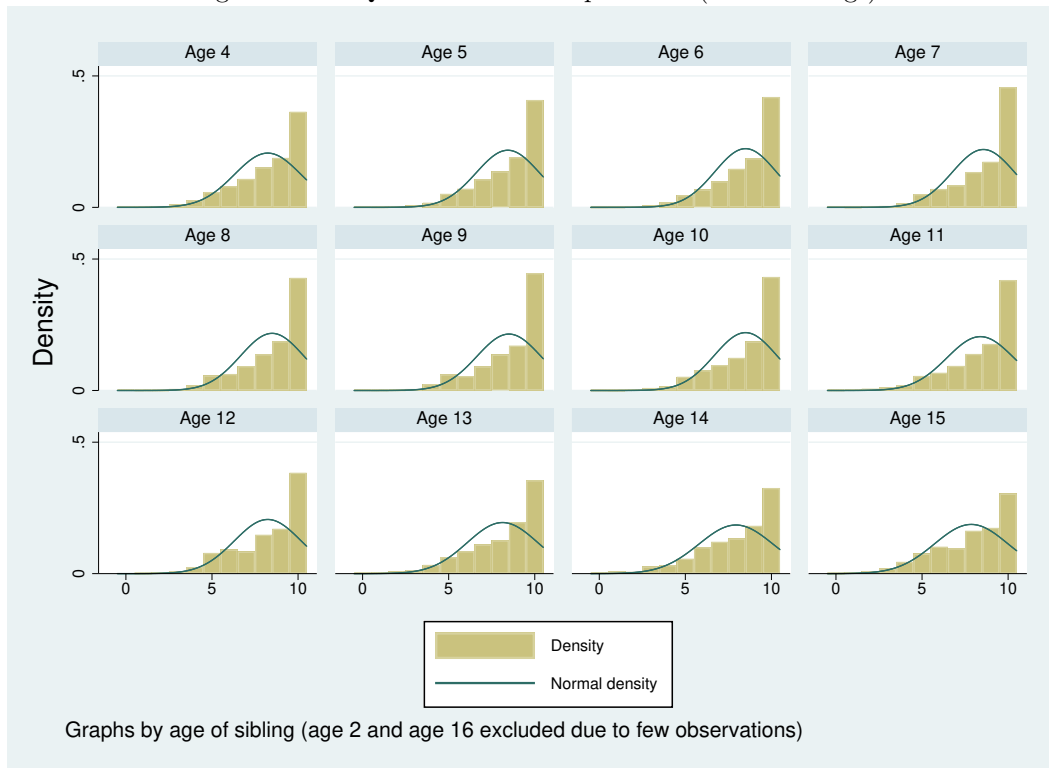
Table 1: Descriptive Statistics - Cohort Members' sample

	Wave 2 (proportion)	Wave 3 (proportion)
Psychological distress (Malaise Inventory)	0.14	0.14
Male	0.51	0.51
Presence of older siblings living in HH (S1)	0.58	0.58
Mother with Postpartum depression and older children than CM living in HH	0.09	0.09
Mother smoked during pregnancy of CM	0.22	0.22
Mother drank alcohol when pregnant of CM	0.32	0.31
Mother: longstanding illness, disability or infirmity	0.22	0.22
Mother ethnic group: White (S1)	0.89	0.88
Mother ethnic group: Mixed (S1)	0.01	0.01
Mother ethnic group: Indian (S1)	0.02	0.02
Mother ethnic group: Pakistani (S1)	0.04	0.05
Mother ethnic group: Bangladeshi(S1)	0.03	0.03
Mother ethnic group: Black Caribbean (S1)	0.01	0.01
Natural father present in HH (S1)	0.85	0.85
Mother highest academic qualification: NVQ level 1 (S1)	0.08	0.08
Mother highest academic qualification: NVQ level 2 (S1)	0.3	0.3
Mother highest academic qualification: NVQ level 3 (S1)	0.15	0.15
Mother highest academic qualification: NVQ level 4 (S1)	0.29	0.29
Mother highest academic qualification: NVQ level 5 (S1)	0.04	0.04
Mother highest academic qualification: Overseas qual only (S1)	0.02	0.02
Mother highest academic qualification: none of the standard ones (S1)	0.12	0.12
Mother is a lone parent (S1)	0.15	0.15
Parents are married (S1)	0.61	0.61
Parents are cohabiting (S1)	0.24	0.24
Mother and partner in work (S1)	0.46	0.46
Mother in work, partner not (S1)	0.02	0.02
Partner in work, mother not (S1)	0.31	0.31
Mother and partner not in work (S1)	0.06	0.07
Mother in work or on leave, no partner (S1)	0.04	0.04
Mother not in work nor on leave, no partner (S1)	0.11	0.11
Maternal Grandmother is alive (S1)	0.93	0.93
Maternal Grandfather is alive (S1)	0.84	0.84
Pollution, environmental problems (S1)	0.22	0.22
Country at interview: England	0.61	0.61
Country at interview: Wales	0.16	0.15
Country at interview: Scotland	0.13	0.13
Country at interview: Northern Ireland	0.1	0.11
Observations	13201	13207

Notes: S1 stands for Wave 1 when the cohort member was 9 months old.
HH stands for household, CM stands for Cohort Member.

Table 2: Cohort Member's behaviours (last percentile of the SDQ score distribution)

	Wave 2 (Age 3)		Wave 3 (Age 5)	
	proportion	N. observations	proportion	N. observations
SDQ Emotional Symptoms	0.18	13201	0.10	13207
SDQ Conduct Problems	0.10	13170	0.10	13199
SDQ Hyperactivity/Inattention	0.14	13052	0.10	13141
SDQ Peer Relationship Problems	0.12	13054	0.16	13167
SDQ Anti-social behavior*	0.18	13070	0.15	13190

Notes: * First percentile of the behavioural dimension SDQ score distribution.

Table 3: Other Descriptive Statistics (Cohort Members' sample)

	Wave 2 (Age 3)				Wave 3 (Age 5)			
	mean	sd	min	max	mean	sd	min	max
Age of cohort member (days)	1145.35	74.21	969	1667	1905.56	90.87	1608	2238
Number of siblings in HH plus CM (S1)	1.9	1.02	1	10	1.91 1.03		1	10
Age of the mother's at CM's birth	28.74	5.85	14	47	28.68	5.84	14	48
Ln of predicted eq. weekly net family income (S1)	5.81	0.73	3	7	5.8	0.73	3	7
Observations	13201				13207			

Notes: S1 stands for Wave 1 when the cohort member was 9 months old.
HH stands for household, CM stands for Cohort Member.

Table 4: Descriptive Statistics - Older siblings' sample

	Wave 2 (proportion)	Wave 3 (proportion)
Psychological distress (Malaise Inventory)	0.16	0.15
Male	0.52	0.52
Half-brother/Half-sister	0.17	0.15
First born vs. others	0.69	0.65
Mother is a lone parent (S1)	0.12	0.11
Parents are married (S1)	0.69	0.71
Parents are cohabiting (S1)	0.19	0.18
Mother ethnic group: White (S1)	0.87	0.87
Mother ethnic group: Mixed (S1)	0.01	0.01
Mother ethnic group: Indian (S1)	0.02	0.02
Mother ethnic group: Pakistani (S1)	0.06	0.06
Mother ethnic group: Bangladeshi(S1)	0.03	0.03
Mother ethnic group: Black Caribbean (S1)	0.01	0.01
Mother: longstanding illness, disability or infirmity (S1)	0.23	0.23
Mother smoked during pregnancy of CM	0.24	0.23
Mother drank alcohol when pregnant of CM	0.31	0.31
Mother highest academic qualification: NVQ level 1 (S1)	0.09	0.09
Mother highest academic qualification: NVQ level 2 (S1)	0.31	0.31
Mother highest academic qualification: NVQ level 3 (S1)	0.13	0.13
Mother highest academic qualification: NVQ level 4 (S1)	0.26	0.27
Mother highest academic qualification: NVQ level 5 (S1)	0.03	0.03
Mother highest academic qualification: overseas qual. only (S1)	0.03	0.03
Mother highest academic qualification: none of these (S1)	0.15	0.15
Natural father of older sibling and CM interviewed (S1)	0.67	0.7
Mother and partner in work (S1)	0.4	0.4
Mother in work, partner not (S1)	0.02	0.02
Partner in work, mother not (S1)	0.38	0.39
Mother and partner not in work (S1)	0.09	0.09
Mother in work or on leave, no partner (S1)	0.02	0.02
Mother not in work nor on leave, no partner (S1)	0.1	0.09
Maternal Grandmother is alive (S1)	0.92	0.92
Maternal Grandfather is alive (S1)	0.81	0.81
Pollution, environmental problems (S1)	0.22	0.22
Country at interview: England (S1)	0.62	0.62
Country at interview: Wales (S1)	0.15	0.15
Country at interview: Scotland (S1)	0.12	0.11
Country at interview: Northern Ireland (S1)	0.11	0.12
Observations	9540	8659

Notes: S1 stands for Wave 1 when the cohort member was 9 months old.
HH stands for household, CM stands for Cohort Member.

Table 5: Older siblings behaviours (last percentile of the SDQ score distribution)

	Wave 2		Wave 3	
	proportion	N. observations	proportion	N. observations
SDQ Emotional Symptoms	0.1	9540	0.1	8659
SDQ Conduct Problems	0.14	9534	0.12	8652
SDQ Hyperactivity / Inattention	0.12	9506	0.1	8636
SDQ Peer Relationship Problems	0.1	9510	0.11	8646
SDQ Anti-social behavior *	0.16	9519	0.17	8653

Notes: * First percentile of the behavioural dimension SDQ score distribution.

Table 6: Other descriptive statistics (older siblings' sample)

	Wave 2				Wave 3			
	mean	sd	min	max	mean	sd	min	max
Age of siblings	7.63	2.98	4	16	9.32	2.53	6	15
Number of siblings in HH plus number of CM's (at CM's birth)	2.78	0.93	2	10	2.87	1.03	2	10
Age of the mother's at CM's birth	30.46	5.11	16	47	30.54	5	16	46
Ln of predicted equivalised weekly net family income (S1)	5.85	0.65	3	7	5.87	0.65	3	7
Observations	9540				8659			

Notes: S1 stands for Wave 1 when the cohort member was 9 months old.
HH stands for household, CM stands for Cohort Member.